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(54) Dishwasher with drying system

(57) A dishwasher has a wash chamber (10a) with openings (12,20) by which humid air is drawn out by a fan and cooled before being returned to the chamber. The fan (18) comprises two stages (18a,18b), a first stage (18a) for drawing out the humid air and for returning it to the wash chamber (10a), and a second stage (18b) for drawing fresh air from outside the chamber and for using it for cooling the humid air drawn out from the wash chamber (10a), therefore condensing the water vapour contained in such humid air.

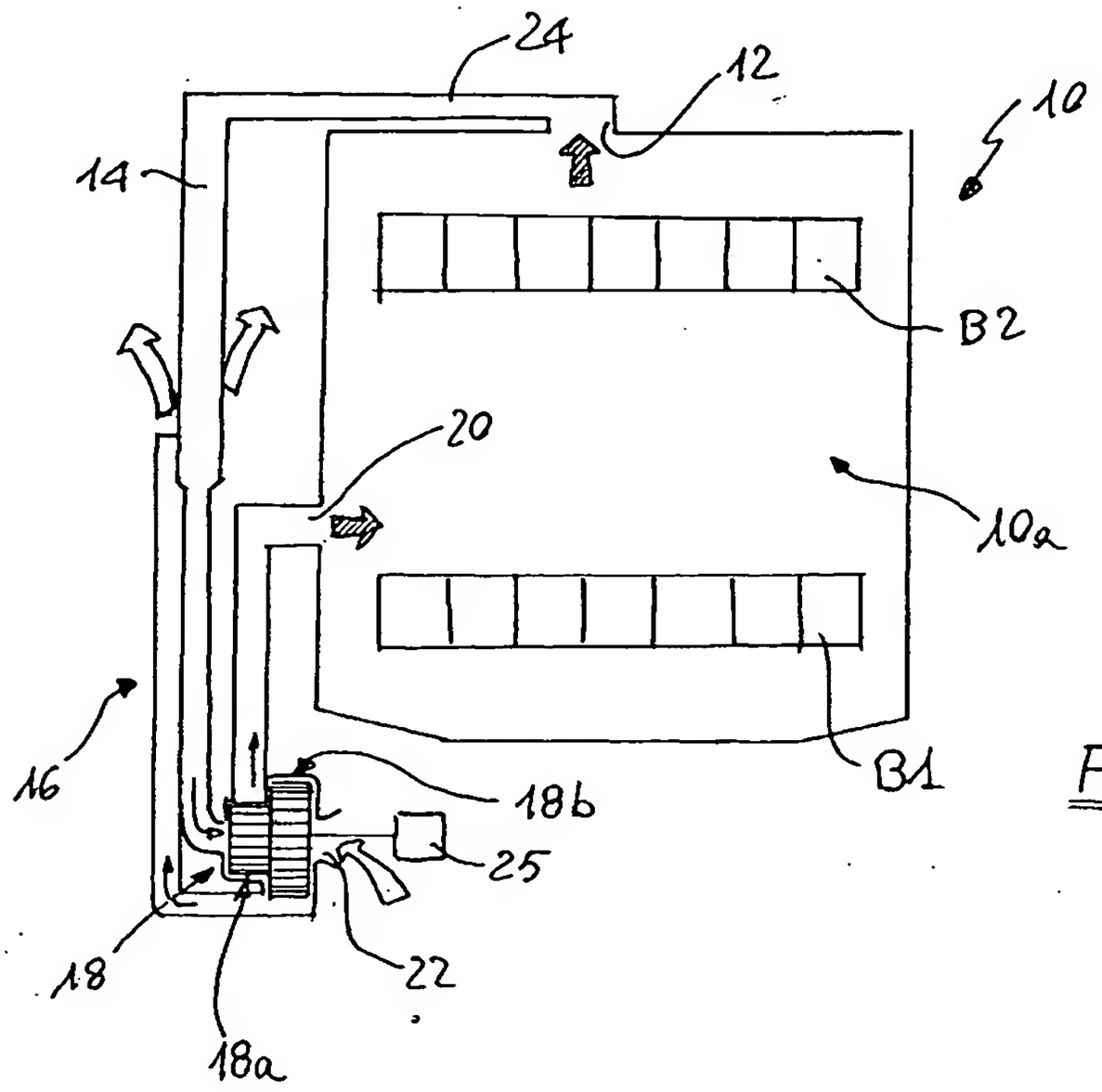

Fig. 1

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Description

[0001] The present invention relates to a dishwasher with a device for drying dishes with air-cooled condenser. More particularly the present invention relates to a dishwasher having a wash chamber with openings by which humid air is drawn out by a fan and cooled before being returned to the chamber.

[0002] A dishwasher of this kind is disclosed by EP-A-1142528 in which the humid air drawn out from the wash chamber is cooled by means of a water container before being returned through a flap valve. Such known system works with a water-cooled condenser in circulated-air operation and it achieves insufficient drying results for an initial temperature of under about 63 °C. In addition, such known systems are less suitable for hot water connection, and they are more complex and expensive.

[0003] Other known drying systems are distinguished by the fact that they either operate in exhaust-air operation only, using a condenser with a regular wall thickness typically of more than 1 mm, or that the humid air completely exits to the surroundings, with or without fresh air being added (with or with out mixing control with humid air). When the air that is saturated with water vapour cools down at objects or components outside the dishwasher, there may be condensation on the surfaces of furniture, for example, and consequential damages. Moreover these systems are either not suitable for elevated installation in the fitted kitchen (column mounted) or for a full door or their drying performance is not optimal, i.e. they do not achieve an "A" rating for the drying performance in a drying interval of under 40 min or they need additional heating energy.

[0004] Therefore, an object of the present invention is to ensure drying under any installation conditions, at low initial temperature (rinsing temperature at the end below about 59 °C), and high drying performance in a simple manner and securely, quickly, and at low cost.

[0005] According to the invention, this object is achieved in that the fan comprises two stages, a first stage for drawing out the humid air and for returning it to the wash chamber, and a second stage for drawing fresh air and for using it for cooling the humid air drawn out from the wash chamber.

[0006] Preferably in the drying system according to the present invention an air-cooled plastic condenser is used. During the drying phase, air containing water vapour is removed from the washing area by a suction device through one or more openings in the top area of the wash chamber, it is passed through a condenser outside the washing area and returned to the washing chamber over an adapter piece, while at the same time the condenser, which is specifically designed for this purpose, is cooled by fresh air. The two-stage fan works as follows. The humid air is blown through a humid-air channel and the cooling air (fresh air) is blown through a fresh-air channel. The two channels are in heat-exchange relationship in the condenser (heat exchanger) in a counter-current process. In this process, a predetermined amount of humid air is preferably mixed with the cooling air without exceeding the relative humidity of the surrounding air.

[0007] The invention will be described and the operation will be explained with reference to the attached drawings in which:

- Figure 1 is a diagrammatic view showing a dishwasher according to the invention, particularly with reference to its drying system;
- Figure 2 is a detailed perspective view of the dishwasher of figure 1, in which a component (adapter lid) of the drying system has been removed;
- Figure 3 is an enlarged view of a detail of figure 2;
- Figure 4 is an exploded view of the detail shown in figure 3;
- Figure 5 is a plan view according to arrow V of a component of figure 3; and
- Figure 6 and 7 are two schematic cross sectional views of the drying system according to two different embodiments of the invention.

[0008] With reference to figure 1, a dishwasher 10 comprises a washing chamber 10a containing an upper and a lower basket B1 and B2. The washing chamber 10a presents an upper opening 12 (two in the version shown in figures 2 and 3) connected to a plastic condenser 14 and, through a fan adapter 16, to the inlet of a first stage 18a of a two stages fan 18. The air is sucked by the first stage 18a and then fed by such first stage again to the wash chamber 10a, through the adapter 16 and through an opening 20 placed on the sidewall of the wash chamber. The second stage of the fan 18, indicated as 18b, presents a suction opening 22 though which fresh air is blown in the adapter 16 and then on the outside surface of the plastic condenser 14.

[0009] Therefore the drying system basically consists of four parts: a top box 24, the condenser 14, the adapter piece 16 (fan adapter), and the two-stages fan 18.

[0010] The top box 24 has the task of collecting the humid air which was sucked out of the inside of the washing chamber 10a through one or more openings 12 and leading it to the condenser 14. The top box 24 is attached to the wash chamber 10a with ring nuts 24a.

[0011] In the condenser 14, the humidity is removed according to the counter-current principle. The material of the condenser is a plastic material that usually has insulating properties. However, since the wall thickness is preferably below 1 mm, the heat transmission coefficient is close to that of metals. The plastic condenser 14 is preferably designed as an extrusion profile with an outer wall thickness of about 0.5 mm. The 0.5 mm thick walls are used as a heat transmission surface.

[0012] After the water vapour is removed from the air (the condenser 14 is provided with means for discharging the condensed water in the wash chamber 10a, not shown in the drawings), the dried air is led to the fan

adapter 16, and from there to the first stage 18a of the two-stage fan wheel 18, after which it is blown back into the wash chamber 10a (see arrows H in figure 5). Inside the wash chamber, the warm dishes saturate the air with humidity again before it runs through the cycle again.

[0013] In the second fan stage 18b, cool fresh air is sucked through the base area and motor compartment and blown across the condenser 14. This cools down the condenser (see arrows C in figure 5).

[0014] The fan 18 (figure 4) comprises a two-stage centrifugal fan wheel 19, the first stage of which is completely inside the fan adapter 16, a separator panel 21, which separates the two stages 18a and 18b from each other, a fan casing 23 for covering the second stage 18b and an electric motor 25 for the drive. The fan wheel 19 comprises a circular plate 19a that, together with the separator panel 21, separates the two stages 18a and 18b of the fan 18. On both sides of the circular plate 19a there are a plurality of shaped fins 19a and 19b respectively.

[0015] The fan adapter 16 comprises a plastic component 16a which defines an housing 28 for the first stage 18a of the fan wheel 19, having an opening 28a for sucking humid air. The plastic component 16a is also provided with an external shaped side walls 30 and internal partitions 32 which, together with a lid 34, defines the channels either for the flow of humid air toward the first stage 18a of the fan 18 or from the second stage 18b towards the outside surface of the condenser 14. Even if in the example shown in the drawings the fresh air is blown from the fan adapter 16 on the condenser 14, without being guided on it, it is possible to provide a prolonged portion of the adapter 16 or an accessory thereof in order to have a guided fresh air channel along the outside surface of the condenser 14.

[0016] The humid air from inside the chamber 10a is continuously turned over by the first fan stage 18a, and the humidity is removed. This air recycling creates a light air current inside the chamber, which dries off the last drops on the crockery. Such gentle drying process reduces the stain formation due to quickly drying drops.

[0017] The second fan stage 18b sucks in fresh air in the base area and the motor compartment, blows it across the condenser 14, and cools it down from the outside on both sides. Then the warmed up cooling air exits into the kitchen through the top area between the working surface and the control panel over the entire width of the dishwasher, creating a barely noticeable and pleasantly warm air current.

[0018] In the area of the separator wall 21, between the casing 23 and the fan wheel 19, a defined gap, which is created by the opening diameter D for the fan wheel (figure 4) and the outer diameter of the fan wheel 19 itself, ensures that a predetermined part of the pre-condensed humid air can be diverted from inside the chamber to the cooling air channel before it is led back to the inside of the chamber (as indicated by dotted arrows L in figure 6).

[0019] The amount of the diverted part of warm air is determined by the design of the separator panel 21 in the area of the gap and by the consequently created flow pattern. In order to keep the total balance of the volume flow inside the chamber, the diverted air volume is replaced by fresh air, which flows through the regenerating dosage system and the door gaps.

[0020] In case of a pure recycling-air operation (without an exhaust airflow outside the dishwasher), the gap is designed as a labyrinth seal, preventing an air exchange.

[0021] Instead of the above "gap solution", according to another embodiment of the invention shown in figure 7, the diversion of a portion of exhaust air can be achieved by a bypass 35 provided in the fan adapter 16.

[0022] With the technical solution according to the present invention, very good drying results are achieved by a closed system with an exhaust air fraction (humidity management) even for initial temperatures for drying below 55 °C.

[0023] The exhaust air fraction can be adjusted at design level between 0% and approx. 40%, offering high flexibility for different installations of the dishwasher. It is also possible, in the embodiment shown in figure 7, to have an adjustment of the bypass ratio before installing the dishwasher and depending on the working conditions of the appliances (this adjustment can be carried out by the technician installing the appliance or by the customer). In case of high initial temperature (approx. 63 °C) and sufficiency long drying period (approx. 40 min.) drying can even be performed effectively in exclusive circulating-air operation (without any exhaust air).

[0024] For sufficiently high rinse temperature (above 65 °C) and sufficiently long drying time, good drying results are achieved even without rinse aid. Moreover the solution according to the invention may be used for integrated dishwashers with full door without the need for the customer to make an opening in the continuous kitchen base or the door decor.

[0025] The cooling current exits into the surroundings between the working surface and the control panel across the entire width, creating a pleasantly warm and barely noticeable airflow. Consequently, installation at a higher level than the floor (fully built-in) in the fitted kitchen becomes possible.

[0026] During the drying phase, the humid air, which exits into the surroundings from all dishwashers during the heating phase during washing and rinsing due to the expansion of the chamber volume, is driven away from the direct surroundings of the device. Other advantages of the present inventions are as follows: the dishwasher may be connected either to cold or hot water; there is no condensation on floor or furniture; drying does not require additional energy; the emission of detergent and rinse aid to the surroundings (kitchen) is reduced to a minimum; the initial temperature for drying may be below 59 °C, with related energy saving.

Claims

1. Dishwasher having a wash chamber (10a) with openings (12, 20) by which humid air is drawn out by a fan and cooled before being returned to the chamber, **characterised in that** the fan (18) comprises two stages (18a, 18b), a first stage (18a) for drawing out the humid air and for returning it to the wash chamber (10a), and a second stage (18b) for drawing fresh air and for using it for cooling the humid air drawn out from the wash chamber (10a).

2. Dishwasher according to claim 1, **characterised in that** it comprises a condensing chamber (14) in which the humid air drawn by the first stage (18a) of the fan flows, the second stage (18b) of the fan blowing fresh air along an external surface of the condensing chamber (14).

3. Dishwasher according to claim 2, **characterised in that** the fresh air is blown substantially in countercurrent with the humid air flowing in the condensing chamber (14).

4. Dishwasher according to any of the preceding claims, **characterised in that** the fan (18) is adapted to provide an air passage from its first stage (18a) to its second stage (18b) in order to discharge a predetermined portion of the humid air drawn from the wash chamber to the outside.

5. Dishwasher according to claim 4, **characterised in that** such air passage is defined by a predetermined gap between a fan wheel (19, 19a) and a casing (21, 28) of the fan (18).

6. Dishwasher according to claim 4, **characterised in that** such air passage is defined by a by-pass opening (35) in the housing (21, 28) of the fan (18).

7. Dishwasher according to claim 2, **characterised in that** it comprises adapter means (16) interposed between the fan (18) and the wash chamber (10a) and adapted to collect humid air from the wash chamber (10a), to direct such humid air towards the first stage (18a) of the fan (18), to direct the humid air blown by said first stage (18a) towards the condenser chamber (24), and to direct fresh air blown by the second stage (18b) of the fan (18) towards the outside surface of the condensing chamber (24) in heating exchange relationship therewith.

8. Dishwasher according to any of the preceding claims, **characterised in that** the fan (19) is a centrifugal fan comprising a fan wheel (19) having a circular plate (19a) on both side of which a plurality of fins (19,c, 19d) are placed.

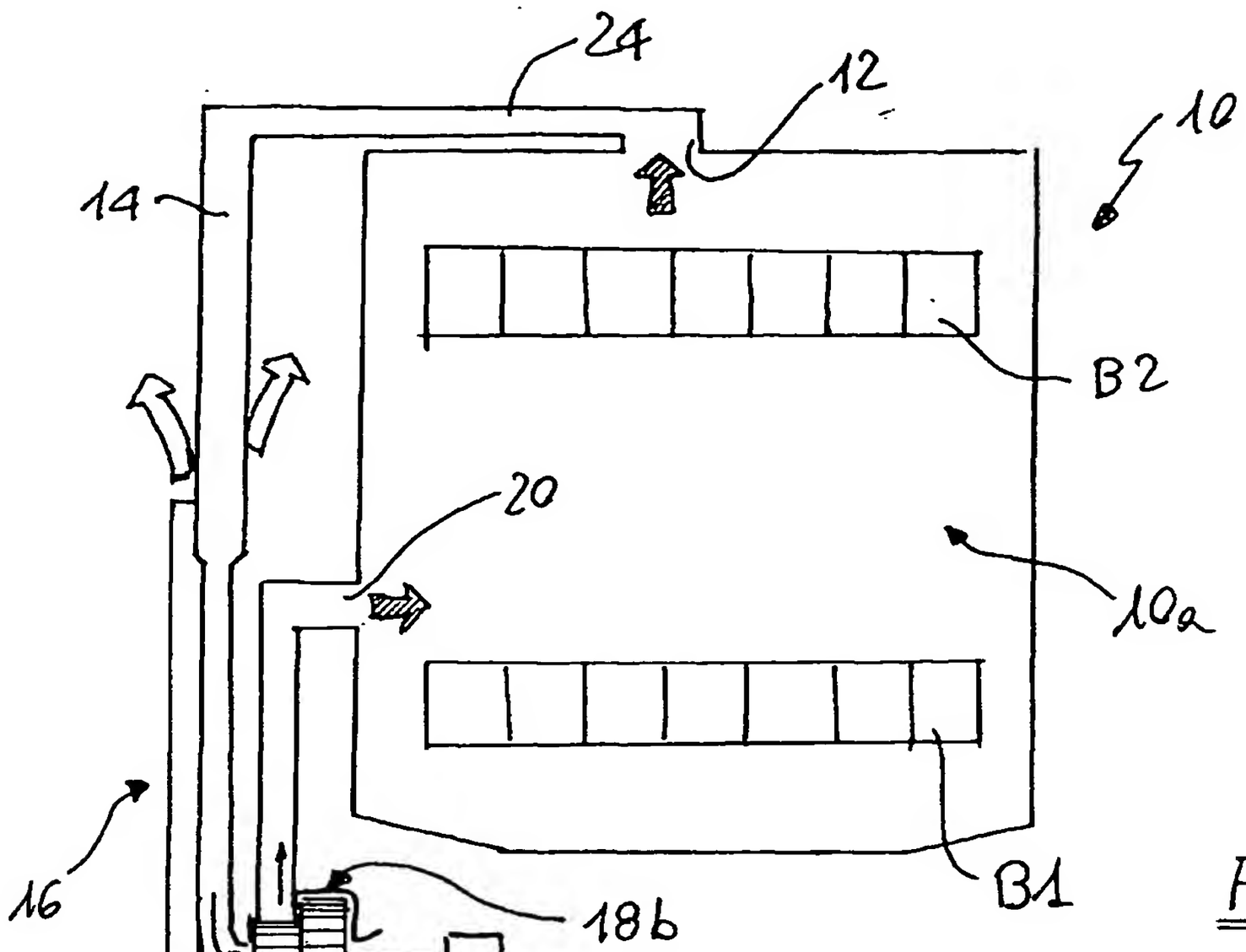

Fig. 1

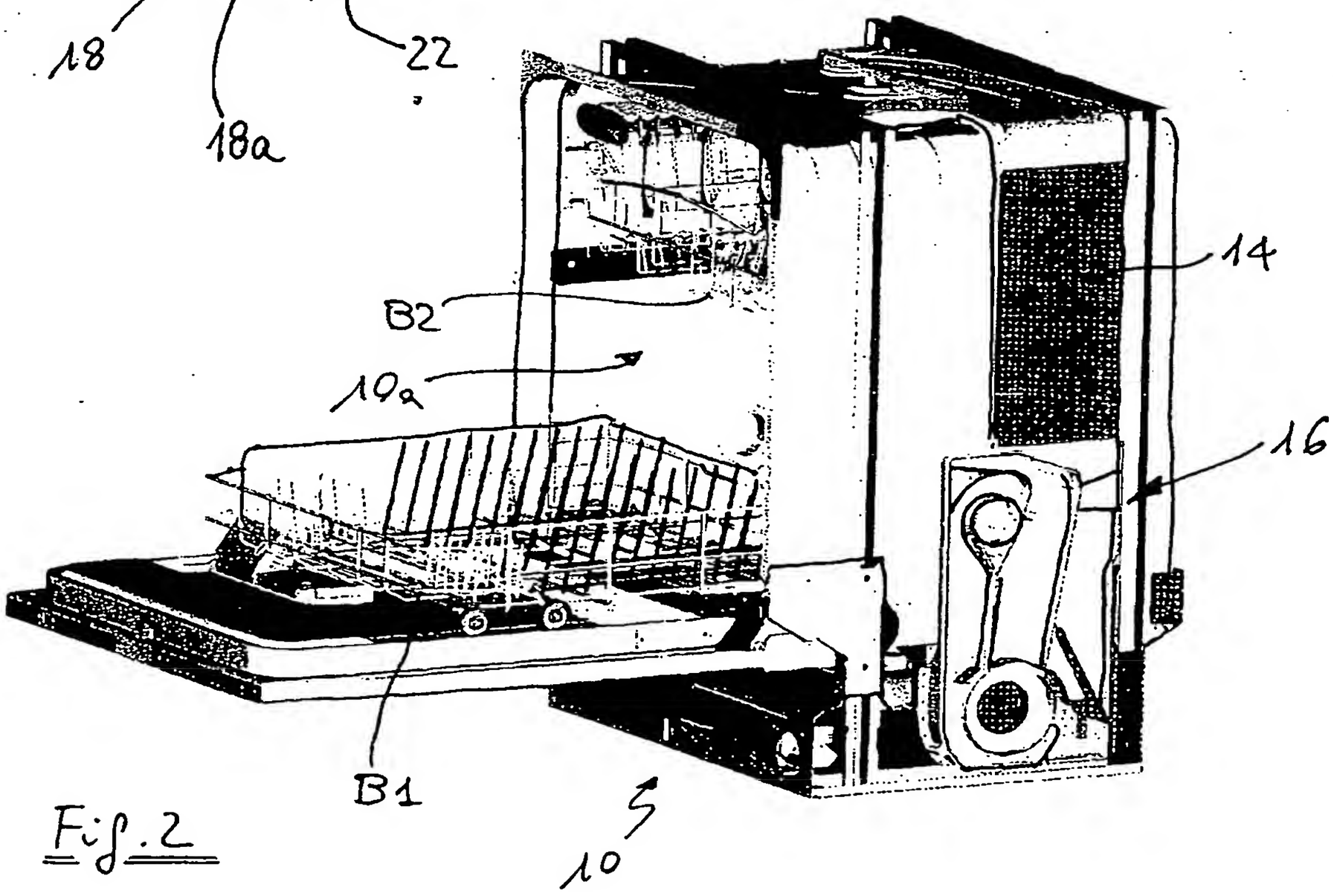

Fig. 2

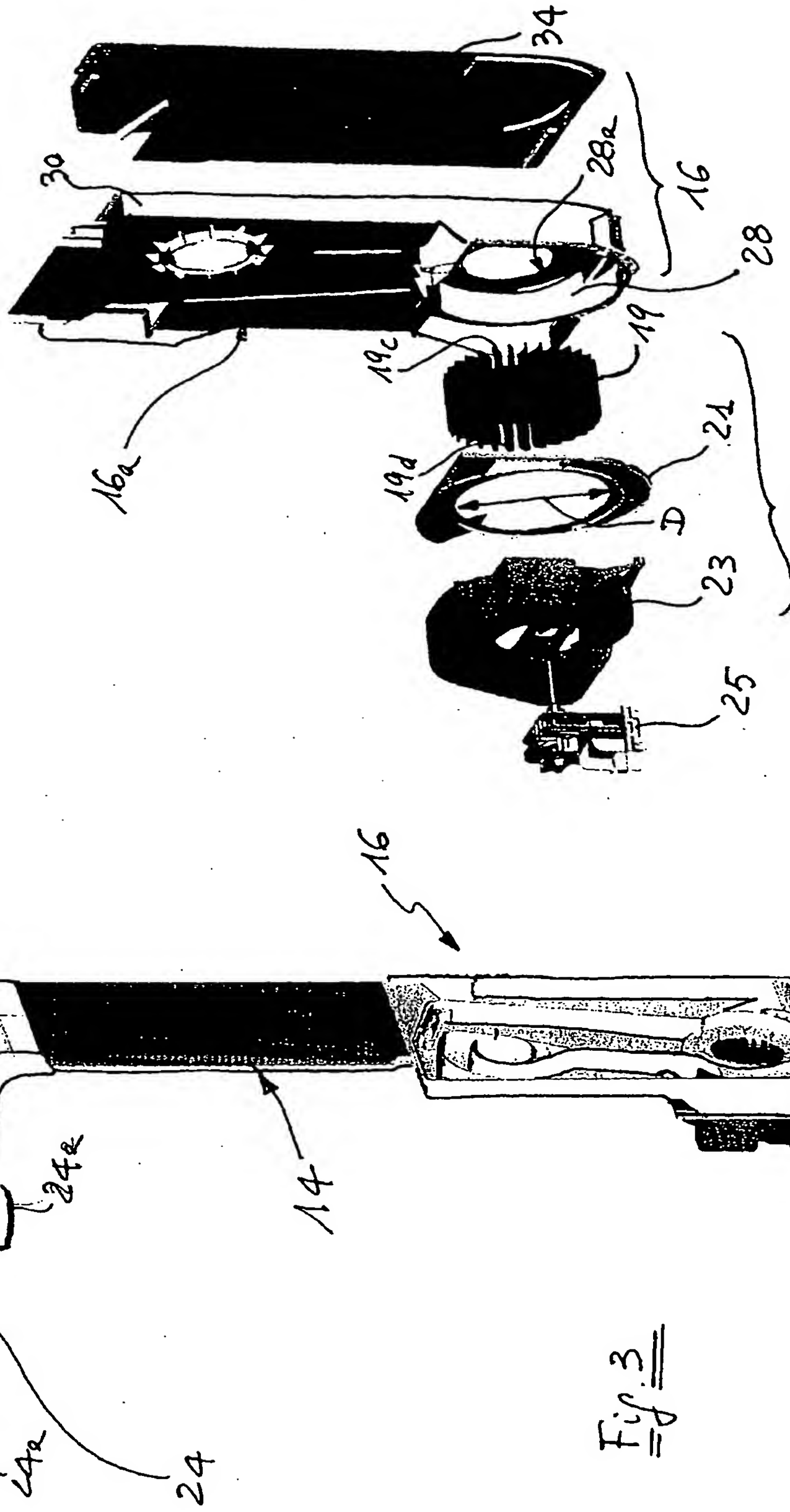

Fig. 4

Fig. 3

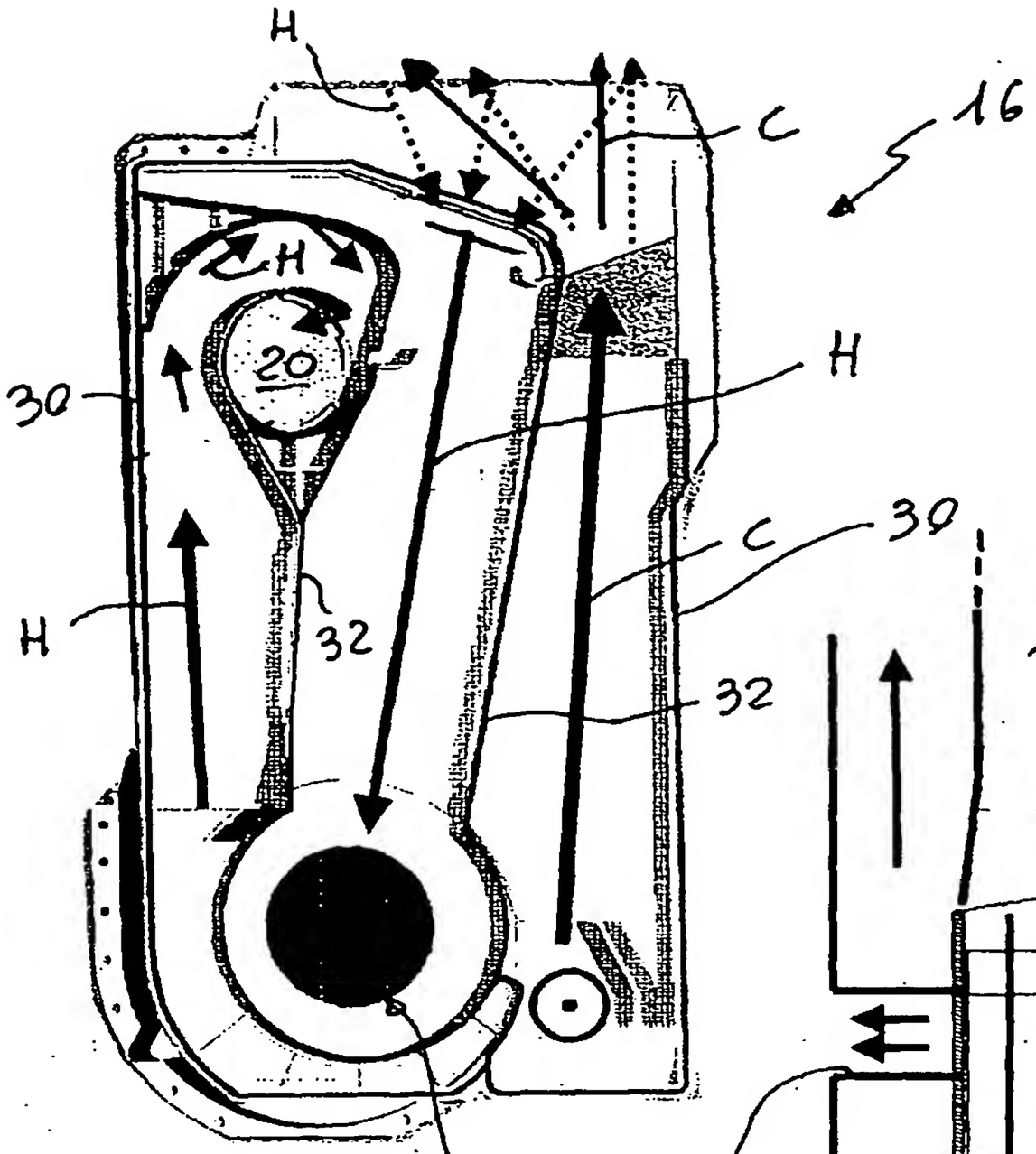
H
C
16
H
20
30
H
32
32

Fig. 5

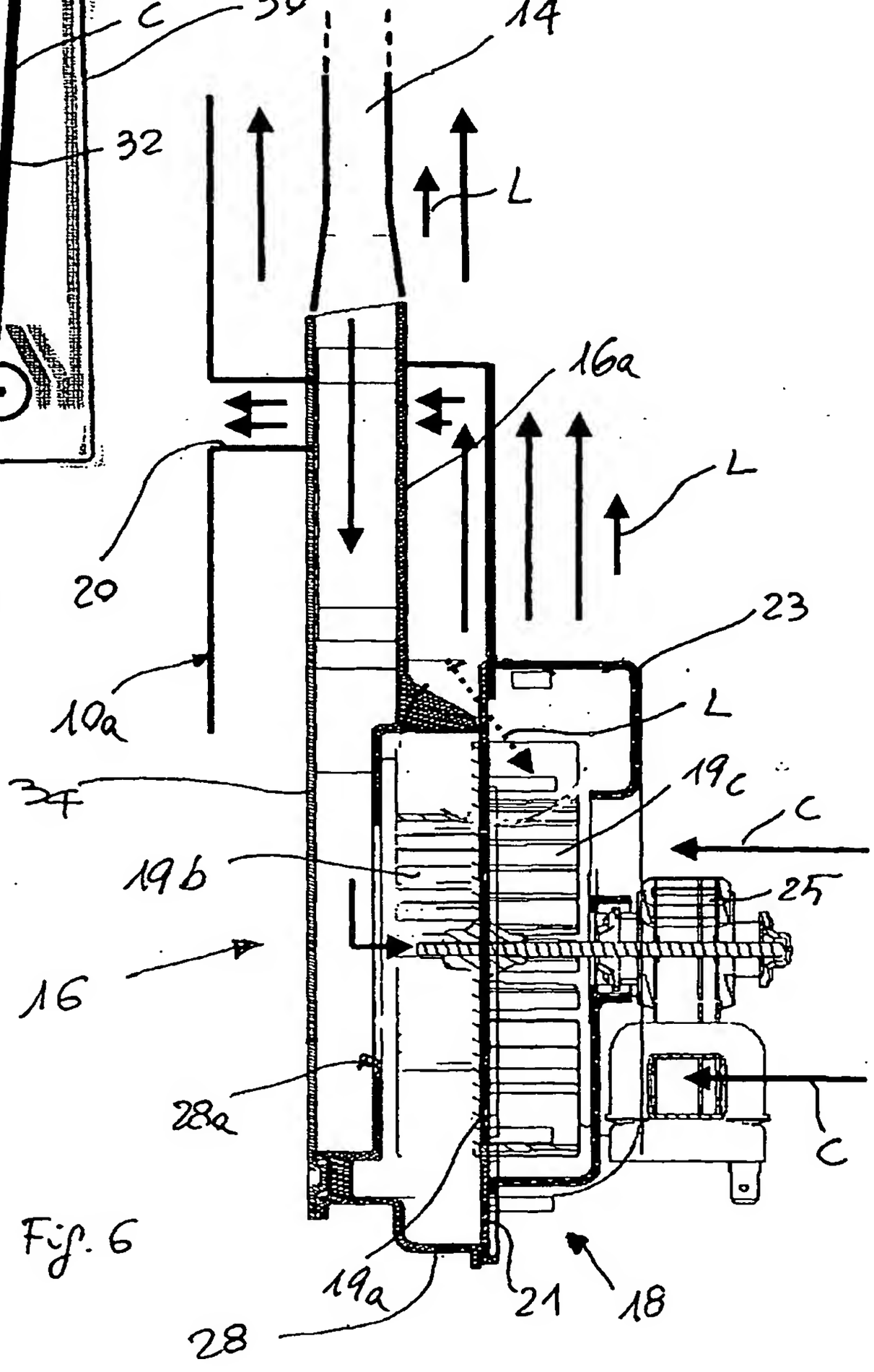
30
C
14
L
16a
L
20
23
10a
L
34
19c
19b
C
25
16
28a
C
19a
21
18
28

Fig. 6

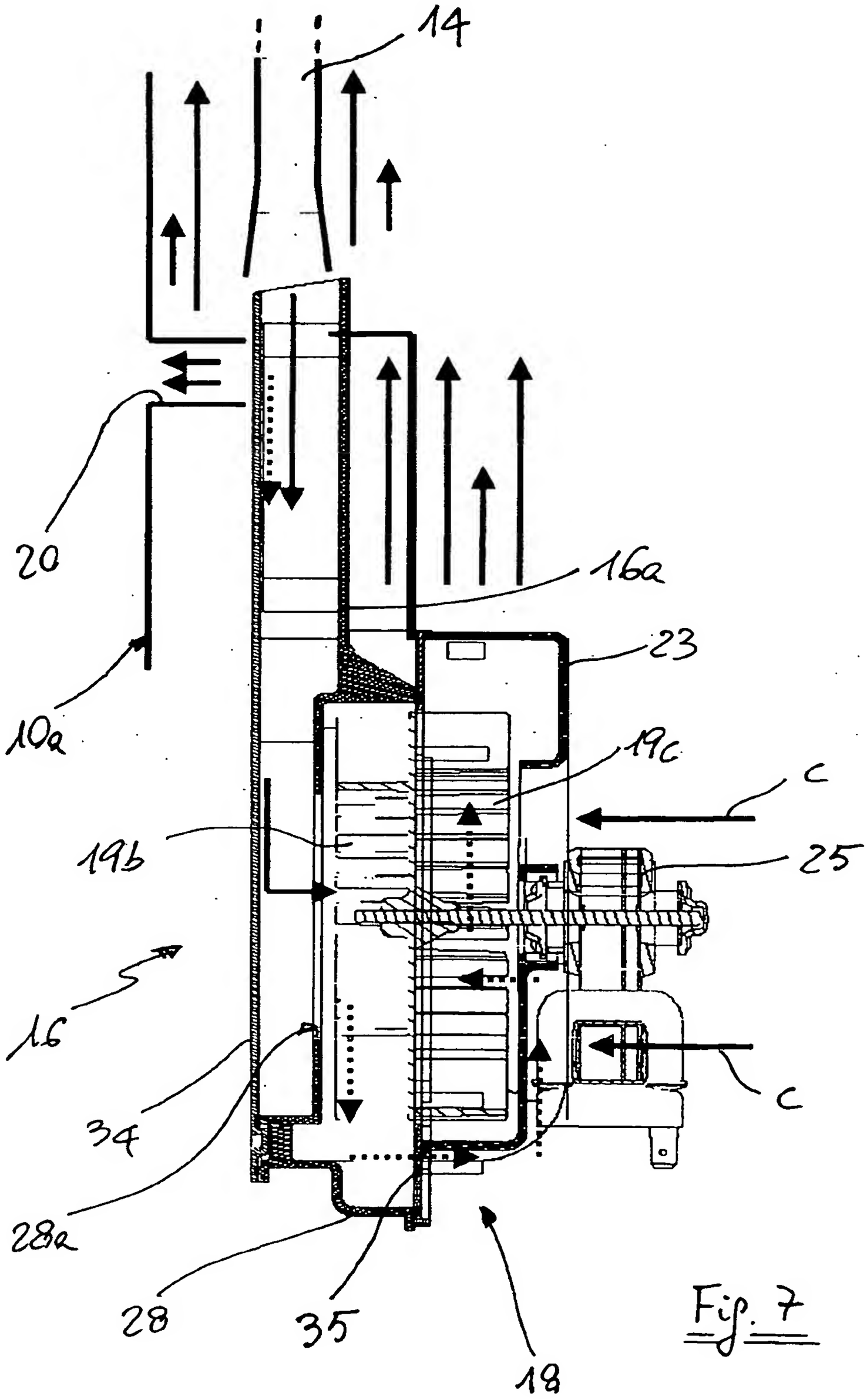

Fig. 7

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EUROPEAN SEARCH REPORT

Application Number
EP 03 00 2650

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X	US 5 076 306 A (SANYO ELECTRIC CO. LTD.) 31 December 1991 (1991-12-31) * column 4, line 1 - line 32 * * column 5, line 17 - line 31; figures *	1-3,7,8	A47L15/48
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TECHNICAL FIELDS SEARCHED (Int.Cl.7)
A47L

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	22 July 2003	Courrier, G

CATEGORY OF CITED DOCUMENTS

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